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ASSIGNMENT BOOKLET
SCN3260 Physics 30
Module 8 Assignment

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Physics 30

LearnEveryWare

we explore

Nuclear Decay, Energy and the Standard Model of the Atom

Module 8

Assignment Booklet

Red Deer Catholic Regional Schools

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FOR TEACHER'S USE ONLY

Summary

	Total Possible Marks	Your Mark
Lesson 1 Assignment	29	
Lesson 2 Assignment	24	
Lesson 3 Assignment	16	
Lesson 4 Assignment	19	
	88	

Teacher's Comments

Physics 30 Learn EveryWare
Module 8: Nuclear Decay, Energy, and the Standard Model of the Atom
Assignment Booklet
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Other	

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MODULE 8: LESSON 1 ASSIGNMENT

This Module 8: Lesson 1 Assignment is worth 29 marks. The value of each assignment and each question is stated in the left margin.

(29 marks) Lesson 1 Assignment: The Nucleus and Radioactive Decay

(2 marks) **RC 1.** On the Geiger Counter simulation, select americium-241 as the isotope and select “air” as the barrier. Start the count and complete the data table below. How do you know what type of decay is occurring?

Alpha	
Beta	
Gamma	

(3 marks) **RC 2.** Switch the barrier to “smoke,” start the counter, and complete the data table below. How is a Geiger counter like a smoke detector?

Alpha	
Beta	
Gamma	

(2 mark) **RC 3.** Switch the isotope to “no isotope,” start the counter, and complete the data table. How can you account for any radioactivity when there is no isotope?

Alpha	
Beta	
Gamma	

(1 mark) **RC 4.** Select uranium-238 as the isotope and air as the barrier. Start the counter and record the number of alpha particles detected. Move the Geiger counter away from the isotope and start the count again. Record the new activity. Complete the table below by continuing to move the Geiger counter away from the isotope.

Distance (mm)	Alpha Count
10	
20	
50	
100	
200	
300	
400	

(3 marks) **RC 5.** Graph the recorded count versus distance of separation. Does the intensity of the radiation obey the inverse square rule? Explain how this graph could be used to find the minimum safe distance from a radioactive source.

(1 mark) **RC 6.** Experiment with different types of barriers. Which material is the best shield from decay radiation?

(4 marks) **RC 7.** Repeat RC 4 for cobalt-60. Make a table to organize your data for beta and gamma decays. Graph the information as in RC 5. What relationship do you see?

Distance (mm)	Alpha Count
10	
20	
50	
100	
200	
300	
400	

(1 mark) **LAB 1.** On the Nuclear Decay Gizmo, select “Show Equation.” Press the play button and add the missing information to the following equation:

$^{238}_{92}\text{U} \longrightarrow$			$+$		

LAB 2. Vary the “starting element” on the simulation and observe alpha decay for several other isotopes.

(1 mark) a. Is the atomic mass (number of nucleons) conserved on both sides of the equation? How can you tell?

(1 mark) b. Is the atomic number (number of protons or positive charges) conserved on both sides of the equation?

(1 mark) c. What particle is always produced in alpha decay?

(1 mark) **LAB 3.** On the simulation, select “show equation.” Press the play button and add the missing information to the following equation:

${}^{14}_{6}\mathrm{C} \longrightarrow$			$+$		

LAB 4. Vary the “starting element” on the simulation and observe beta decay for several other isotopes.

(1 mark) a. What happened to the neutron?

(1 mark) b. Is the atomic mass conserved on both sides of the equation?

(1 mark) c. Is the atomic number conserved on both sides of the equation? Where did the new proton come from?

(1 mark) d. Which particle is always produced in beta decay?

(4 marks) **D 3.** If you were to update your questions on nuclear radiation based on what you learned in D 2, what changes would you make? Submit your revised summary and comments on the changes that you made to your instructor as part of your assignment.

MODULE 8: LESSON 2 ASSIGNMENT

This Module 8: Lesson 2 Assignment is worth 24 marks. The value of each assignment and each question is stated in the left margin.

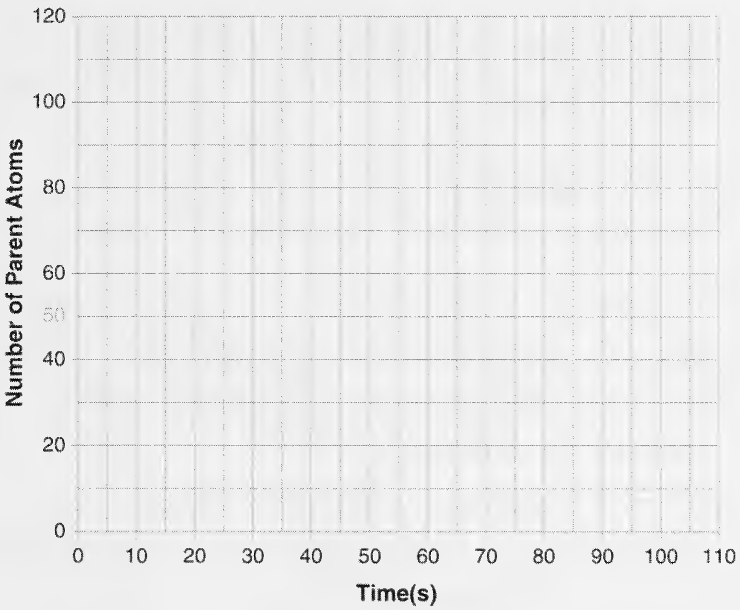
(24 marks) Lesson 2 Assignment: Decay Rates and Radioactive Dating

A simulation will be used to explore the rate of radioactive decay and the concept of half-life. Open the Half-life Simulation. Use the controls on the right side of the simulation to activate the animation.

(1 mark) **LAB 1.** In the simulation there is a chamber of 128 radioactive atoms represented by red spheres. Click Play (▶) and observe. Over time, describe what happens to the relative amount of parent nuclei (red) and daughter nuclei (grey).

(1 mark) **LAB 2.** Reset the simulation and select the “BAR CHART” tab. Click play and observe. Compare the rate of change from parent to daughter nuclei throughout the decay process. Is the rate of particle decay constant through time? If not, did it speed up or slow down over time?

(1 mark) **LAB 3.** Reset the simulation and select the “GRAPH” tab. Click play and observe. Sketch the half-life curve.



(1 mark) **LAB 4.** Select a different isotope from the drop-down menu and observe its decay graph. Does it have exactly the same shape as the other isotope decay curve? What does this suggest about the nature of decay?

LAB 5. The rate of decay of a radioactive isotope is described by its half-life. On the simulation, ensure that the half-life is set to 20 seconds and select "Theoretical decay" from the second drop-down menu. Check that the initial number of atoms is 128. Select the "TABLE" tab and click play.

(1 mark) a. At 20 seconds, how many of the original 128 radioactive atoms remained?

(2 marks) b. How many remained at 40 seconds? 60 seconds? 80 seconds? 100 seconds? What is the pattern?

(1 mark) **LAB 6.** If there are 100 radioactive atoms with a half-life of 30 seconds, how many radioactive atoms will remain after one half-life (30 seconds)? How many will remain after two half-lives (60 seconds)? three half-lives? Use the simulation to check your answers

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LAB 7. The half-life of a radioactive isotope is defined as the amount of time it takes for half of the radioactive particles to decay. Start with 128 particles and a half-life of 30 seconds. ("Theoretical decay" should still be selected.) Select the "GRAPH" tab and click play. Turn on the half-life probe and ensure it is on the *y*-axis of the graph. (You can "grab" and drag the probe by clicking on one of the purple triangles or the line between.)

(1 mark) a. What is the time value and number of radioactive particles at the beginning of the interval measured by the probe? What is the time value and number of radioactive particles at the end of this interval? How are these two numbers related to the definition of half-life?

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(1 mark) b. Drag the probe to different parts of the graph. Does the same pattern persist?

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LAB 8. On the drop-down menus, select "Isotope A" and "Theoretical decay." Set the number of Atoms to 128 and click play.

(1 mark) a. According to the graph, what is the **approximate** half-life of isotope A?

(1 mark) b. Select the "TABLE" tab. According to the data table, what is the **exact** half-life of isotope A?

(1 mark) c. Suppose you analyzed a sample of isotope A that contained 25 radioactive isotope A atoms and 103 stable daughter atoms. Approximately how old is the sample?

(1 mark) d. About how old is a sample of isotope A with 75 radioactive atoms and 53 daughter atoms?

(1 mark) e. Click reset. Change the number of atoms to 50 and click play. Does this change the half-life of isotope A? Confirm this by experimenting with other starting numbers. Does this mean that radioactive dating does not depend on the amount of radioactive nuclei at the start? Explain.

LAB 9. Set the number of atoms to 100 and check that "Isotope B" and "Theoretical decay" are selected. Click play and view the results on the "GRAPH" tab. To model how scientists might dated an artifact, imagine that the y-axis represents the percentage of radioactive atoms, and that each second on the x-axis represents 1000 years. Assume this is true.

(1 mark) a. What is the age of an artifact with 50% radioactive atoms of isotope B?

(3 marks) b. What is the estimated age of a sample with 25% radioactive atoms of isotope B? 12%? 6%?

(1 mark) c. About how old is a sample with 72% radioactive atoms of isotope B?

(3 marks) **RC 1.** Predict the percentage of remaining carbon-14 (half-life = 5730 years) in an ancient wood sample that is known to be 2500 years old.

(1 mark) **RC 2.** Explain how this prediction could be used to measure the accuracy of radiocarbon dating.

MODULE 8: LESSON 3 ASSIGNMENT

This Module 8: Lesson 3 Assignment is worth 16 marks. The value of each assignment and each question is stated in the left margin.

(16 marks) Lesson 3 Assignment: Fission and Fusion

(2 marks) **LAB 1.** Which variables control the reactor temperature and how does an operator adjust them?

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(2 marks) **LAB 2.** Describe the combination of variables that leads to the quickest meltdown.

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(2 marks) **LAB 3.** Describe the combination of variables that prevent the reactor core from generating heat.

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(2 marks) **LAB 4.** Which type of control rod is most effective and why?

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(2 marks) **LAB 5.** Which type of coolant works best for safely generating electricity?

(6 marks) **RC 1.** Complete the following table comparing and contrasting various issues related to nuclear fusion and fission.

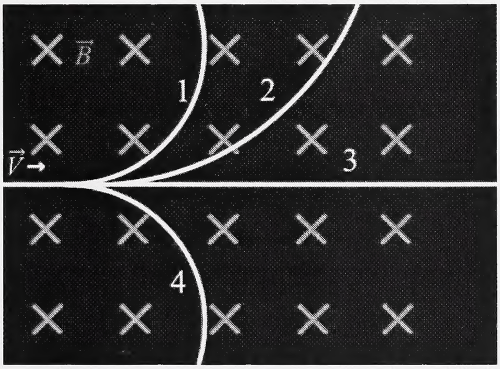
Issue	Fusion	Fission
How is the change in binding energy achieved?		
What is the relative size of the nuclei used as the fuel source?		
How abundant is the fuel source?		
What is the environmental impact of the reaction?		
How safe is the technology?		
How easy is it to sustain the reaction?		

MODULE 8: LESSON 4 ASSIGNMENT

This Module 8: Lesson 4 Assignment is worth 19 marks. The value of each assignment and each question is stated in the left margin.

(19 marks) Lesson 4 Assignment: The Subatomic World

(4 marks) **A 1.** Explain how to use the following diagram of the bubble chamber paths of an alpha particle, beta particle, beta positive particle, and a gamma ray to determine which path corresponds to which particle.



There are more lines on the next page.

(2 marks) **A 2.** Compare and contrast matter and antimatter.

(1 mark) **A 3.** Give an example of a matter–antimatter pair you have already seen in Physics 30, other than electron–positron.

(2 marks) **A 4.** Which particles are involved when an up quark changes into a down quark?

(2 marks) **A 5.** Which particles are involved when a down quark changes into an up quark?

(2 marks) **RC 1.** Name two famous physicists shown in the video and state why they are famous as physicists.

(2 marks) **RC 2.** What are two physics discoveries that have been made at CERN in the past 50 years?

(2 marks) **RC 3.** Why is CERN (the European Organization for Nuclear Research) significant for scientists worldwide and what does it show about cooperation in the scientific community?

(2 marks) **RC 4.** State two ways that the application of the work at CERN has changed life for everyday people.

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